Acta Pharm. 45 (1995) 379–381

Phenology, occurrence of epicormic branches and reproductive growth in air-polluted silver firs

KATARINA ČUFAR[1*]
DUŠAN ROBIČ[2]
NIKO TORELLI[1]
ANDREJ KERMAVNAR[3]

[1]*Dept. of Wood Sci. & Technol., University of Ljubljana, Večna pot 2, 61000 Ljubljana*

[2]*Dept. of Forestry, University of Ljubljana, Večna pot 30, 61000 Ljubljana*

[3]*Forest Enterprise Ljubljana, Tržaška 2, 61000 Ljubljana*

Silver fir (*Abies alba* Mill.) trees in Slovenia have been dying over the past decade. The precise etiology of decline is not known but air pollution is considered to be part of the problem. Interestingly, within the same site, some mature trees remain healthy while others are declining or dying. In the present study the phenology of shoot growth, occurrence of epicormic branches (secondary crown) and reproductive growth (megastrobili and microstrobili) have been observed and their relation to tree decline evaluated.

MATERIALS AND METHODS

Since 1988 observations of 440 variously affected, adult (150 – 220 years), dominant or codominant silver firs (*Abies alba* Mill.) originating from two representative areas of silver fir/beech forests (Ravnik and Bistra) have been performed.

The crown damage was assessed visually in the 1987 growing season according to a slightly modified system after Bosshard (1). Trees classified 1 were included in the sample as apparently healthy, those classified 2 as slightly affected and those classified 3 as heavily affected.

At the same time the occurrence of epicormic branches forming the secondary crown was determined as follows: 0 – epicormic branches absent, 1 – sporadic, 2 – oc-

* Correspondence

currence intermediate, 3 – frequent, forming continuous secondary crown along the stem, below and within the primary crown.

Observations of the phenology and reproductive growth were performed in 1988, 1989 and 1990 and partly in 1992 and 1993.

Phenological observations of shoot growth began immediately before bud breaking (April/May) and were performed every three days till the maximum length of shoots was achieved (end of June). Because of considerable phenological differentiation within each tree, only the upper third of the primary crown, excluding the apex, was observed. The phenological phases were determined according to a modified method after Bulygin (2): 1– bud swelling, 2–, 3– intermediate phases, 4– extension growth, 5– the extension growth is finished, the shoot hangs down.

The quantity of megastrobili and microstrobili was determined in May and June, when they appeared most distinct.

The results were evaluated by the analysis of contingency tables.

RESULTS AND DISCUSSION

The trees included in the sample belonged to all grades of damage. Only circa 20% of trees from Bistra and about 40% from Ravnik were assessed as unaffected. In the period between 1988 and 1992, 20% (Bistra) and 10% (Ravnik) dying or dead trees were sanitary felled.

Among five phases of shoot growth, the time of bud breaking (phase 1) proved to be most significant. Based on the data for phase 1 (1990), from a 3 × 3 contingency table a significant positive association ($C_{cor} = 0.5532^{***}$; C_{cor} – corrected contingency coefficient) between the state of tree health and phenology was determined. 65% of late flushing silver firs were found to be unaffected and 66.7% of early flushing trees were heavily affected. On average, heavily affected trees flushed 5 days earlier than nonaffected ones.

The presence of a secondary crown was characteristic of affected trees. The association between the state of health and the secondary crown, calculated from a 3 × 3 contingency table, was high and significant ($C_{cor} = 0.6135^{***}$). 78% of unaffected silver first did not have epicormic branches, but 93% of heavily affected trees had abundant epicormic branches forming a secondary crown.

No association between the occurrence of a secondary crown and phenology could be determined ($C_{cor} = 0.2825^{**}$). From partial associations between the state of health and phenology for (a) trees with secondary crown ($C_{cor} = 0.5475^{***}$) and (b) trees without secondary crown ($C_{cor} = 0.5099^{***}$), it could be concluded that presence of secondary crown did not affect the relation between the state of health and time of flushing.

In both plots, trees without reproductive organs could be found in all damage classes. Among affected trees, those without megastrobili and microstrobili predominated. It was statistically confirmed that the frequency of megastrobili decreased with increased damage ($C_{cor} = 0.517^{***} – 0.597^{***}$). The association between the state of health and frequency of microstrobili was significant only in a plot with a better tree condition (Ravnik, $C_{cor} = 0.323^{***} – 0.559^{***}$).

In conclusion, it can be assumed that affected silver firs are characterized by earlier flushing, more abundant epicormic branches and by a reduced formation of male and female reproductive organs. Epicormic branches presumably occur as a consequence of redistribution of hormones due to crown (and/or root) damage. Assuming that the phenological characteristics are at least partly inherited (3), genetic factors could be among the reasons why on the same site, some trees remain unaffected and others progressively decline.

REFERENCES

1. W. Bosshard, (Ed.), *Kronenbilder,* Eidgenössische Anstalt für das forstliche Versuchswesen, Birmensdort 1986.
2. N. E. Bulygin, *Dendrologiya fenologicheskie nabljudenia nad hvojnymi porodami,* LTA Leningrad, 1974.
3. G. E. Shul'ts, *Obshchaya fenologiya.* Nauka, Leningrad 1981.